TREATMENT TECHNOLOGY FOR AUTO FLUFF

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INTRODUCTION Auto fluff is the non-metallic material that remains after junked automobiles are stripped and then shredded to recover their metal (primarily ferrous) and other valuable components. The composition of auto fluff varies, however, it is generally comprised of scrap metal (wire, molding, etc.), plastic, vinyl, leather, cloth, sponge, foam, glass, and other non-combustibles. In addition, traces of lead, cadmium, chromium, and mercury are present along with organic compounds, such as oil, antifreeze, transmission and brake fluids, and polychlorinated biphenyls (PCB).

It is estimated that each year, the 200 or so automobile shredders[1] in the U.S. generate as much as 3 to 4 million tons of auto fluff.[2] Currently, most auto fluff is sent to municipal landfills or is stored on the site of the auto shredder facilities. The presence of PCBs and heavy metals in auto fluff render some samples hazardous wastes according to the U.S. Environmental Protection Agency (EPA) Toxicity Characteristic Leaching Procedure (TCLP). These materials must be stored in specially designed land- or monofills. The reduction of existing landfill capacity, mounting disposal costs and more stringent legislation on auto fluff disposal have spurred the development of alternative methods of disposing or reducing the volume of material that must be landfilled.

TWO-STAGE AGGCOM COMBUSTOR The Institute of Gas Technology (IGT) is developing the two-stage fluidized-bed/cyclonic agglomerating (AGGCOM) combustor (Figure 1) for treating soils and other materials, such as auto fluff, that are contaminated with both organic and inorganic compounds. The AGGCOM combustor combines the fluidized-bed gasification and cyclonic combustion technologies that have been developed at IGT over many years. The AGGCOM combustor efficiently destroys organic compounds and encapsulates inorganic contaminants within benign, glassy agglomerates suitable for disposal in ordinary landfills.

The first stage of the combustor is a sloping-grid, agglomerating fluidized-bed reactor that can operate under either substoichiometric or excess air conditions. In addition to the sloping grid, the first stage incorporates a central jet and classification section. Fuel gas and air enter the central jet while only air is admitted through the grid and classifier. The contaminated waste material is admitted directly into the fluidized bed. With a unique distribution of fuel and air, the bulk of the fluidized bed is controlled at a temperature of 1500° to 2000°F, while the central spout temperature can be varied from 2000° to 3000°F. This feature is key to the combustor's ability to produce benign agglomerates. Upon introduction of contaminated wastes into the bed, the organic fraction is immediately volatilized and partially combusted. The inorganic fraction undergoes melting and subsequent agglomeration.

Volatilized organic compounds are destroyed in the second stage of the AGGCOM combustor. This second stage is a cyclonic combustor, which provides intense mixing to ensure complete combustion of these organic compounds. Either secondary air or a mixture of fuel gas and air is fed to this stage to maintain a temperature in the range of 1800° to 2400°F. The destruction and removal efficiency (DRE)

of organic contaminants in the AGGCOM system is expected to exceed 99.99% (99.9999% for PCBs, dioxins, etc.). Fine particulates collected in the cyclonic stage are returned to the fluidized-bed stage for assimilation in the agglomerates.

EPA SITE PROGRAM A multiyear program is currently underway at IGT to develop a data base for application of the AGGCOM technology at Superfund sites. The program is sponsored by the U.S. EPA Superfund Innovative Technology Evaluation (SITE) program, IGT's Sustaining Membership Program, and the Gas Research Institute. The program includes soil agglomeration tests in a 6-inch diameter fluidized-bed bench-scale unit (BSU), the design, construction, and operation of a 6-ton/day AGGCOM pilot plant, and the utilization of the pilot plant data to assess the commercial viability of the technology. The primary objectives of the program include 1) determining the operating conditions in the fluidized bed that, for a given contaminated soil, will enhance the capture and encapsulation of inorganic contaminants within the glassy matrix, 2) identifying operating conditions in both AGGCOM stages for the destruction of organic contaminants with a DRE to exceed 99.99%, and 3) minimizing utility requirements by maximizing process heat recovery.

The batch BSU tests with commercially available top soil were successfully completed; conditions required to produce soil agglomerates were determined. Samples of agglomerated soil were shown to be essentially non-leachable per the TCLP. Construction of the AGGCOM pilot plant has been completed and testing is underway.

AUTO FLUFF TESTS IGT conducted an experimental program to determine the operating conditions necessary for combusting auto fluff and for agglomerating the inorganic fraction of auto fluff. The University of Illinois (Chicago, UIC) participated in the program as a subcontractor to IGT. A bulk sample of auto fluff was obtained from a local auto shredder. Physical and chemical analyses of the bulk sample of auto fluff were determined (Table 1).

Fluidization tests were conducted with as-received and ground (-½ inch) auto fluff and with auto fluff ash generated in the fluidized-bed combustor at UIC. The objective of the tests was to determine the fluidization characteristics of the auto fluff and ash. The raw and ground auto fluff did not fluidize well. The ash from the fluidized-bed combustion test behaved like discrete particles and the results from this test were considered more representative of the fluidization expected in the BSU. A minimum fluidization value (U_{mf}) of 1.5 ft/s (0.45 m/s) was selected as the best compromise for both raw fluff and combusted ash.

Feeding of the ground auto fluff to the BSU with existing equipment was also difficult. The 1½-inch screw was not capable of discharging auto fluff from the 6-inch diameter feed hopper. After much modification and testing, IGT and UIC developed an auger-stirred feed hopper that could effectively meter auto fluff into a horizontal pocket feeder. With air assist, this feed system could consistently feed up to 15 lb/h of auto fluff into the BSU.

The combustion/agglomeration tests were conducted in the BSU with natural gas as the secondary fuel. The bottom of the BSU is fitted with a sloping-grid gas distributor, including venturi discharge, and central burner jet for generating the hot zone. Cyclones are installed downstream of the BSU to collect fine particles elutriated from the fluidized bed. A product gas scrubber is also used to capture fine particles not removed by the cyclones. The BSU is equipped with external electric heaters for achieving temperatures up to 2000 °F and a feed gas preheater.

Three auto fluff combustion/agglomeration tests were conducted in the BSU. Each test consisted of several set points in an attempt to identify conditions required to agglomerate the inorganic fraction of auto fluff. The operating conditions were temperatures of 1560 ° to 1950 °F, superficial fluidization

velocities of 2.3 to 4.6 ft/s (about twice the U_{mf}), and auto fluff feed rates of 3.0 to 4.9 lb/h. Auto fluff agglomerates (Figure 2) were produced in two of the tests.

Three auto fluff combustion tests were also conducted in the UIC 6-inch diameter fluidized-bed reactor. The test conditions were temperatures of 1250° to 1590°F, fluidization velocities of 2.1 to 3.8 ft/s, and excess air of 12 to 99 percent. On-line gas analyzers indicated that auto fluff was not consistently fed to the bed by the screw feeder. The CO concentration increased and decreased in the range of 100 to over 5000 ppm during auto fluff feeding.

A sample of the ground auto fluff was analyzed for priority trace elements including chlorine. Raw ground auto fluff and the agglomerated auto fluff were subjected to the TCLP test. The trace element analysis and TCLP results are shown in Table 2. The results show that this sample of raw auto fluff has considerable cadmium, chromium, lead, and mercury contents and exhibits a toxic character per the TCLP test (see Cd and Pb concentrations). However, the leachability of the agglomerated auto fluff sample was significantly less than that of the raw fluff and the sample passed the TCLP test.

CONCLUSIONS The results of the bench-scale batch fluidized-bed agglomeration tests demonstrate that the inorganic fraction of auto fluff can be agglomerated via IGT's sloping-grid technology. The leachability of auto fluff agglomerates is less than that of raw auto fluff; the agglomerates pass the TCLP test. Product gas analyses of fluidized-bed combustion of auto fluff indicate that a second stage of cyclonic combustion is required to reduce the CO content to acceptable levels. The chlorine content of auto fluff may require the addition of sorbents to the fluidized bed to reduce HCl emissions to acceptable levels.

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REFERENCES 1. "Detroit - The day of the throw-away car is over," Jack Keebler, Automotive News, March 4, 1991, p. 36.
2. "Process Recovers More From Junked Cars," Irwin Stambler, R&D Magazine, January 1993, p. 14.

Table 1. PHYSICAL AND CHEMICAL CHARACTERISTICS OF AUTO FLUFF

Material	wt % (dry)
Scrap Metal	8.8
Hard Plastic	11.8
Sponge	6.5
Rubber	2.5
Vinyl+Leather	12.3
Carpet+Cloth	3.8
Other Fluffy	39.5
Wood+Cardboard	4.1
Glass	2.7
Dirt+Other	8.0
Total	100.0
Calorific Value, Btu/lb (dry),	7810

Proximate Analysis	wt %
Moisture Content	24.1
Volatile Matter	39.8
Ash	32.8
Fixed Carbon	3.3
Total	100.0

Ultimate Analysis	wt % (dry)
Ash	42.77
Carbon	39.77
Hydrogen	4.58
Nitrogen	0.92
Sulfur	0.25
Oxygen (by diff.)	11.76
Total	100.00

Table 2. TRACE ELEMENT ANALYSES AND TCLP RESULTS ON AUTO FLUFF SAMPLES

Sample	Raw Auto Fluff		Agglomerated Auto Fluff	TCLP Limit
	-- μg/g --	---------- TCLP Leachate Concentration, mg/L ----------		
Arsenic	11	<0.002	<0.05	5
Barium	12	2.1	0.85	100
Cadmium	160	1.5	<0.05	1
Chromium	280	<0.05	0.65	5
Lead	100	7.1	2.8	5
Mercury	1.6	<0.005	<0.001	0.2
Selenium	5.8	0.016	<0.002	1
Silver	<6.0	<0.20	<0.05	5
Chlorine	7700	--	--	--

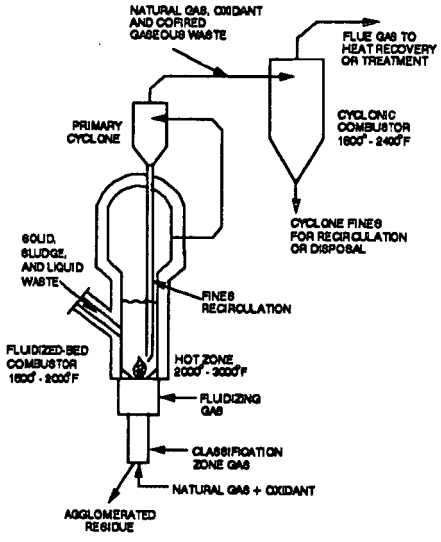

Figure 1. IGT's AGGCOM COMBUSTOR

Figure 2. AGGLOMERATED AUTO FLUFF